

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A superconducting Current Controller for controlling the current in a primary circuit, the combination comprising:

a primary coil coupled to said primary circuit and carrying a first current for generating a first magnetic flux;

a superconducting tube magnetically coupled to said primary coil and carrying a second current induced by said first current, said second current producing a magnetic flux opposing said first magnetic flux to substantially cancel said first magnetic flux when said first current is within a pre-determined range;

a secondary coil magnetically coupled to said primary coil and said superconducting tube; and

a variable impedance coupled in circuit with said secondary coil, whereby when said first current increases beyond a pre-determined range, said second magnetic flux does not completely cancel said first magnetic flux, thereby inducing a current in said secondary coil and, said variable impedance is reflected into said primary circuit to control the current therein.

2. The apparatus of claim 1 wherein an increase in said first current is a fault current and wherein the value of said variable impedance is such as to limit said fault current in said primary circuit.

3. The apparatus of claim 2 further including a ferromagnetic core, said primary coil and said secondary coil being wound about said ferromagnetic core and said superconducting tube extending about said ferromagnetic core.

4. The apparatus of claim 3 characterized in that said ferromagnetic core forms a closed loop.

5. The apparatus of claim 3 wherein said primary coil extends about the exterior of said superconducting tube.

6. The apparatus of claim 3 wherein said superconducting tube consists of a single coil.

7. The apparatus of claim 3 wherein said superconducting tube comprises a plurality of rings arranged in side-by-side relationship to form a tube.

8. The apparatus of claim 3 wherein said core has at least first, second and third sections, said primary coil being formed about said first section, said secondary coil being formed about said second section, and said superconducting tube being formed about said third section of said core.

9. The apparatus of claim 1 further including a control circuit, said control circuit comprising a control coil magnetically coupled to said primary coil and wound to generate a magnetic field adding to the magnetic field of said primary coil;

and a variable current source connected in circuit with said control coil, whereby the value of current generated by said variable current source reflects an impedance in said primary circuit to control the current therein.

10. A superconducting Current Controller for controlling the current in a primary circuit, the combination comprising:

a primary coil ⁽¹⁰⁾ coupled to said primary circuit and carrying a first current for generating a first magnetic flux;

5 a control coil ⁽¹¹⁾ magnetically coupled to said primary coil;

a variable current source in circuit with said control coil, to generate a second current in said control coil such that said control coil generates a second magnetic flux in a direction additive to said first magnetic flux;

10 a superconducting tube magnetically coupled to said primary coil and said control coil and carrying a third current induced by said first current, said third current producing a third magnetic flux opposing said first and second magnetic fluxes to substantially cancel said first and second magnetic fluxes when said first current is within a pre-determined range;

15 whereby when said second current increases beyond a pre-determined value, said third magnetic flux does not completely cancel said first and second magnetic fluxes, and an impedance having a value determined by the magnitude of said second current is reflected into said primary circuit to control the current therein.

20 11. The apparatus of claim 10 wherein an increase in said first current to a fault current exceeds the ability of said superconductor to cancel said first and second fluxes and an impedance sufficient to limit said fault current is inserted in said primary circuit.

1001-1002

12. The apparatus of claim 11 further including a ferromagnetic core, said primary coil and said control coil being wound about said ferromagnetic core and said superconducting tube extending about said ferromagnetic core.

13. The apparatus of claim 12 characterized in that said ferromagnetic core forms a closed loop.

14. The apparatus of claim 12 wherein said primary coil extends about the exterior of said superconducting tube.

15. The apparatus of claim 12 wherein said superconducting tube consists of a single coil.

16. The apparatus of claim 12 wherein said superconducting tube comprises a plurality of rings arranged in side-by-side relationship to form a tube.

17. The apparatus of claim 12 wherein said core has at least first, second and third sections, said primary coil being formed about said first section, said control coil being formed about said second section, and said superconducting tube being formed about said third section of said core.

18. A superconducting Current Controller for controlling the current in a primary circuit, the combination comprising:

a primary coil coupled to said primary circuit and carrying a first current for generating a first magnetic flux;

5 a superconducting tube magnetically coupled to said primary coil and carrying a second current induced by said first current, said second current producing a magnetic flux opposing said first magnetic flux to substantially cancel said first magnetic flux when said first current is within a pre-determined range;

10 a secondary coil magnetically coupled to said primary coil and said primary coil and said superconducting tube;

a variable impedance coupled in circuit with said secondary coil, whereby when said first current increases beyond a pre-determined range, said second magnetic flux does not completely cancel said first magnetic flux, thereby inducing a current in said secondary coil and, said variable impedance is
15 reflected into said primary circuit to control the current therein;

a control coil magnetically coupled to said primary coil and said superconductor tube; and

20 a variable current source in circuit with said control coil to generate a third current in said control coil such that said control coil generates a second magnetic flux in a direction additive to said first magnetic flux such that when said first and second fluxes exceed the ability of said superconductor to cancel said first and second fluxes, said superconductor inserts impedance in said primary circuit.

19. The apparatus of claim 18 wherein an increase in said first current is a fault current and wherein the value of said variable impedance is such as to limit said fault current in said primary circuit.

20. The apparatus of claim 19 further including a ferromagnetic core, said primary coil, said secondary coil and said control coil being wound about said ferromagnetic core and said superconducting tube extending about said ferromagnetic core.

21. The apparatus of claim 20 characterized in that said ferromagnetic core forms a closed loop.

22. The apparatus of claim 20 wherein said primary coil extends about the exterior of said superconducting tube.

23. The apparatus of claim 20 wherein said superconducting tube consists of a single coil.

24. The apparatus of claim 20 wherein said superconducting tube comprises a plurality of rings arranged in side-by-side relationship to form a tube.